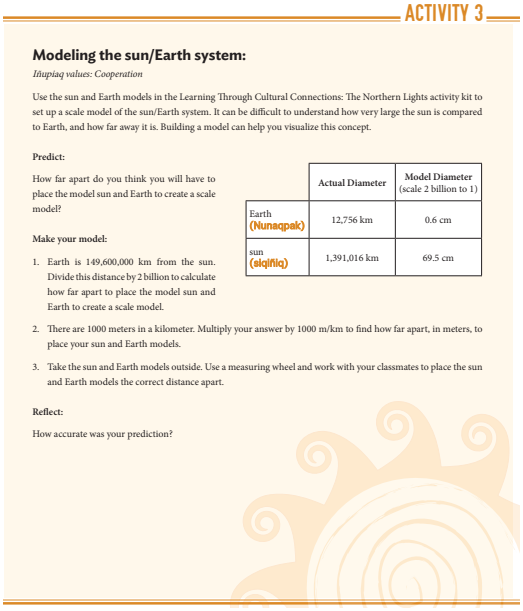
Activity 3: Modeling the Sun/Earth System



ACTIVITY 3

Modeling the sun/Earth system:

Iñupiaq values: Cooperation

Use the sun and Earth models in the Learning Through Cultural Connections: The Northern Lights activity kit to set up a scale model of the sun/Earth system. It can be difficult to understand how very large the sun is compared to Earth, and how far away it is. Building a model can help you visualize this concept.

Predict:

How far apart do you think you will have to place the model sun and Earth to create a scale model?

	Actual Diameter	Model Diameter (scale 2 billion to 1)
Earth (Nunaqpak)	12,756 km	0.6 cm
sun (siqiñiq)	1,391,016 km	69.5 cm

Make your model:

1. Earth is 149,600,000 km from the sun. Divide this distance by 2 billion to calculate how far apart to place the model sun and Earth to create a scale model.
2. There are 1000 meters in a kilometer. Multiply your answer by 1000 m/km to find how far apart, in meters, to place your sun and Earth models.
3. Take the sun and Earth models outside. Use a measuring wheel and work with your classmates to place the sun and Earth models the correct distance apart.

Reflect:

How accurate was your prediction?

Time: 2 class periods (1 class period = 45 min)

Materials:

- Solar system model
- Sun poster (optional)
- Rolling measuring wheel or 100-meter measuring tape
- Modeling the Sun/Earth System Worksheet
- Calculators (optional)

Standards Addressed:

- NGSS: MS-ESS1: Earth's Place in the Universe: MS-ESS1-3
- Alaska Cultural Standards: B.1
- Iñupiat Learning Framework: [B] E.e.1.5, [N] E.e.3.4
- Iñupiaq Cultural Values: Cooperation
- Alaska Science Content Standards: D.3
- Alaska Reading Standards for Literacy in Science and Technical Subjects: Grades 6-8 Students: Standard 3.

Background Information:

Earth and the other planets in our solar system are affected by solar weather. Some even have their own northern lights. Each planet has a unique orbit, tilt and rotation. These determine the length of a year, season and day. Scale models are a useful tool to help students understand and visualize the relative sizes of the sun and Earth, and how far apart they are. Use the sun and Earth models in the Learning Through Cultural Connections: The Northern Lights activity kit to set up a scale model of the sun/Earth system.

	Actual Diameter (NASA data)	**Model Diameter (Scale 2 billion to 1)**
Earth (Nunaqpak$^{NS/NP}$)	12,756 km	0.6 cm
sun (siqiñiq^{NS}/mazaq^{NP})	1,391,016 km	69.5 cm

Assessments:

- Modeling the Sun/Earth System worksheet responses and activity will provide a means of assessing student ability to:
  - analyze and interpret data to create scale models of the sun and Earth and other objects in our solar system;
  - follow precisely a multistep procedure when taking measurements and performing a technical task;
  - cooperate with peers to accomplish a task.
- Classroom discussion will provide a means for assessing student ability to:
  - acquire insights about our solar system from other cultures without diminishing the integrity of their own;
  - read and speak Iñupiaq words related to the northern lights;
  - observe, study and describe the world around him by identifying where outer planets would need to be placed if the solar system model were completed.

Activity Preparation:

Find a place in your classroom to display the model sun (poster or wooden). Assemble the planet models so that each is attached to the correct base.

Activity Instructions:

1. Ask students to work with a partner to read pages 2-7 of the Kiuġuyat[NS] / Kiuġiyaq[NP] Middle School Guide, or work through the booklet as a group, asking students to take turns reading the sentences aloud. Discuss the content and check for comprehension. Ask students: Why is it important to learn about topics from more than one perspective, such as a cultural perspective and a physical science perspective?

2. Show students the model sun. Explain that this is a model sun or (siqiñiq[NS]/mazaq[NP]). Ask students to practice the appropriate Iñupiaq word for sun. Ask: If the sun were this size, what size do you think Earth (Nunaqpak) would be? Ask them to draw their predictions on the whiteboard or chalkboard.

3. Explain that this model sun is based on a 2 billion to 1 scale. For every 2 billion meters a planetary body has in actuality, 1 meter was used. As a class, perform the calculations to determine the diameter of the model Earth (12,756 km ÷ 2,000,000,000 x 100,000 cm/km = .6 cm)

Model distance from the sun in meters:	
Scale of 2,000,000,000:1	
Mercury	29 meters – 2˚
Venus	54 meters – 177.36˚
Earth	74.8 meters – 23.4˚
Mars	114 meters – 25.19˚
Jupiter	389.2 meters – 3.13˚
Saturn	715 meters – 26.73˚
Uranus	1440 meters – 97.77˚
Neptune	2250 meters – 28.32˚
Pluto – Kuiper Belt	2850 meters – 122.5˚
Moon	.192 meters from Earth
Io	.211 meters from Jupiter
Europa	.335 meters from Jupiter
Ganymede	.535 meters from Jupiter
Callisto	2.940 meters from Jupiter
Titan	2.611 meters from Saturn
Triton	2.177 meters from Neptune

4. Show students the model Earth that is .6 cm in diameter. Find the closest prediction sketched on the chalkboard/whiteboard.

5. Distribute the Modeling the Sun/Earth System worksheet. Ask students to predict how far apart they will need to place the sun and Earth to create a scale model. Ask students to write their prediction in meters, then perform the calculations on their worksheet to determine the answer. If your students are new to calculating distance using a scale, consider working through the calculations as a class, or placing students in small groups with a strong math student in each group.

6. Students will determine that the model sun and Earth should be 74.8 meters apart. That is roughly the length of 2 ½ basketball courts! Ask students to discuss with a partner how this compares to their prediction. Were they close? Far off? Are they surprised by the results of their calculations?

7. Ask students to repeat their calculations to determine the scale distance for other planets in our solar system.

8. Show students the planet models and explain that they are accurate, but FRAGILE. As a class, take the sun, inner planet models (Mercury, Venus, Earth, Mars) and the measuring wheel or tape outside. If you are in an area without daylight, consider also taking 5 flashlights outside or choosing a well-lit parking lot or schoolyard for this activity. Place the sun and Earth 74.8 meters apart. Assign groups of students each of the other inner planets and ask them to work together to correctly place their planet (Mercury: 29 meters, Venus: 54 meters, Mars: 114 meters). A student will need to stand in place holding each planet, as they are lightweight and may blow away in the wind.

9. Once the near planets are placed, direct students to look around at their mini solar system. If it is dark, have one student turn on a flashlight at the site of each model. What do they notice? Why did we choose not to place the outer planets? If we had placed them, where would they be? Use landmarks such as people's homes, businesses, and features of geography to help students understand how far away each of the outer planets would be for their model to remain to scale (Jupiter: 389 meters, Saturn: 700 meters, Uranus: 1.45 kilometers, Neptune: 2.25 km, Pluto & Kuiper Belt: 2.95 km). A good way to estimate distance is by thinking about how long it takes to walk there: about 100 meters per minute.

10. Return to the classroom.

11. Discuss as a class: How does the tilt of a planet affect the seasons or weather? What if Earth was tilted 90°, laying on its side? What patterns in your area might change? What month might you plan to look for berries? What month might you expect to bring in a whale?

Connections and Extensions:

- Walk it indoors! Is it too cold and dark to do this activity outside? Find the average distance of each student's pace and then have them "walk off" the distance from the sun to each of the inner planets
- *Challenge* Move it! Do this activity outside where you have enough space to model the orbits. Assign each student a pace to walk. For instance, Earth travels 940 million kilometers during its orbit. For our scale, that would be 470 meters at 1.3 meters a day or 5.3 centimeters an hour. Call out special events such as the Spring Equinox and note where other planets are in their orbit.

Modeling the sun/Earth System[NS]

Name: _____

Follow the steps below to create a scale model of objects in our solar system. This will help you to understand the vast distance between the sun and Earth.

	Actual Diameter (NASA data)	**Model Diameter** (Scale: 2 billion to 1)
Sun (siqiñiq)	1,391,016 km	69.5 cm
Earth (Nunaqpak)	12,756 km	0.6 cm

Predict:

How far apart do you think you will have to place the model sun and Earth to create a scale model?

_____

Make your model:

1. Earth is 149,600,000 km from the sun. Divide this distance by 2 billion to calculate how far apart to place the model sun and Earth to create a scale model.

   149,600,000 km ÷ 2,000,000,000 = _____ km

2. There are 1000 meters in a kilometer. Multiply your answer by 1000 m/km to find out how far apart, in meters, to place your sun and Earth models.

   _____ km x 1000 m/km = _____ m

3. Take the sun and Earth models outside. Use a measuring tape and work with your classmates to place the sun and Earth models the correct distance apart.

Reflect: How accurate was your prediction?

_____

Extend: Use what you have learned and the data below to determine the scale distance from the sun to each planet in our solar system. Add the remaining inner planets (Mercury, Venus, Mars) to your scale model. (Scale: 2 billion to 1)

Planet	**Approximate distance from sun** (in kilometers)	**Scale distance from sun** (in kilometers)	**Scale distance from sun** (in meters)
Mercury	58,000,000		
Venus	108,000,000		
Earth	149,600,000		
Mars	228,000,000		
Jupiter	778,000,000		
Saturn	1,400,000,000		
Uranus	2,900,000,000		
Neptune	4,500,000,000		
Pluto	5,900,000,000		

Modeling the sun/Earth System[NP]

Name: _____

Follow the steps below to create a scale model of objects in our solar system. This will help you to understand the vast distance between the sun and Earth.

	Actual Diameter (NASA data)	**Model Diameter** (Scale: 2 billion to 1)
Sun (mazaq)	1,391,016 km	69.5 cm
Earth (Nunaqpak)	12,756 km	0.6 cm

Predict:

How far apart do you think you will have to place the model sun and Earth to create a scale model?

_____

Make your model:

1. Earth is 149,600,000 km from the sun. Divide this distance by 2 billion to calculate how far apart to place the model sun and Earth to create a scale model.

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2. There are 1000 meters in a kilometer. Multiply your answer by 1000 m/km to find out how far apart, in meters, to place your sun and Earth models.

   _____ km x 1000 m/km = _____ m

3. Take the sun and Earth models outside. Use a measuring tape and work with your classmates to place the sun and Earth models the correct distance apart.

Reflect: How accurate was your prediction?

_____

Extend: Use what you have learned and the data below to determine the scale distance from the sun to each planet in our solar system. Add the remaining inner planets (Mercury, Venus, Mars) to your scale model. (Scale: 2 billion to 1)

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Uranus	2,900,000,000		
Neptune	4,500,000,000		
Pluto	5,900,000,000		